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IS 12549 (1988): Iron nickel cobalt sealing alloys [MTD 16: Alloy Steels and Forgings]

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IS : 12549-1988

(Reaffirmed 2004)

Indian Standard

SPECIFICATION FOR IRON-NICKEL-COBALT SEALING ALLOY

Special Alloys Sectional Committee, SMDC 33 [Ref : Doc : SMDC 33(3351)]

1. Scope — This standard covers the requirement of wrought iron-nickel-cobalt alloy in the form of wire, rod, bar, strip and sheet intended primarily for sealing to glass and for other electronic applications. Tubings are not included under the scope of this specification.

2. Supply of Material — The general requirements relating to the supply of this material shall conform to IS : 1387-1967 'General requirements for the supply of metallurgical materials (*first revision*)'.

3. Chemical Composition, Percent — The chemical composition of the material when determined by gravimetric or spectrochemical analysis shall be as given in Table 1.

TABLE 1 CHEMICAL COMPOSITION, PERCENT

Element	Composition
*Iron, nominal	53
*Nickel, nominal	29
*Cobalt, nominal	17
Manganese, *Max*	0.50
Silicon, *Max*	0.20
Carbon, *Max*	0.04
†Aluminium, *Max*	0.10
†Magnesium, *Max*	0.10
†Zirconium, *Max*	0.10
†Titanium, *Max*	0.10
Copper, *Max*	0.20
Chromium, *Max*	0.20
Molybdenum, *Max*	0.20

*Iron, nickel and cobalt requirements listed are nominal. They shall be suitably adjusted by the manufacturers so that the alloy meets the requirements of coefficient of thermal expansion given in Table 3.

†The total of aluminium, magnesium, zirconium and titanium shall not exceed 0.20 percent.

4. Size and Finish — The iron-nickel-cobalt alloy shall be supplied in any of the sizes and finishes indicated in Table 2 and as stated in the order.

4.1 *Length of Supply for Wires and Rounds*

Wires	Diameters : 0.05 to 0.80 mm	In continuous length wound on spools, nett mass of wire not exceeding 1.5 kg.
	Above 0.80 to 3.00 mm	In coils of continuous length of 10 to 50 kg mass
Rods	Diameters: Above 3.00 to 10.00 mm Above 10.00 to 100.00 mm	1 to 3 metres, other lengths on specific request by the purchasers
Strips	In various thicknesses and widths	Coils of continuous length of 10 to 50 kg mass
Sheets	In various thicknesses and widths	As specified in the order

Adopted 23 September 1987

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Gr 4

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TABLE 2 FORMS OF SUPPLY, FINISHES AND SIZES

(*Clause* 4)

Form	Finish	Size
Wire	Cold drawn Cold drawn and annealed (coiled, spooled or in cut length)	Diameter: 0.05 to 4.00 mm
Round	Cold drawn Cold drawn, ground Cold drawn, annealed Cold drawn, annealed and ground	Diameter: Above 4 to 12 mm
	Hot rolled Hot rolled, peeled Hot rolled, peeled and centreless ground	Diameter: Above 12 to 50 mm
	Hot rolled/forged Hot rolled, forged and turned	Diameter: Above 50 mm
Strip	Cold rolled Cold rolled, annealed	Thickness: 0.05 to 4 mm Width: 5 to 225 mm
Sheet	Cold rolled Cold rolled, annealed	Thickness: 0.8 to 4 mm Width: 1000 mm, *Max* Length: 3000 mm, *Max*

4.2 *Straightness and Flatness* — Wires and rounds supplied in cut lengths shall be reasonably straight and free from bends and twists. Strips and sheets supplied in cut sizes shall be flat and free from warpage and buckling. The deviation in straightness and flatness shall not be more than 3 mm for a length of one metre.

5. Freedom from Defects — Iron-nickel-cobalt sealing alloy supplied in various forms and finishes shall be free from scales, corrosion, cracks, seams, scratches and other surface defects. The material shall be uniform in chemical composition, temper, finish and cross-section.

6. Temper — The desired temper of the material shall be specified in the purchase order.

6.1 *Wire and Rod* — These forms shall be supplied in one of the tempers as specified in Table 4. Unless otherwise stated, the material shall be bright annealed and supplied in temper 'O'.

6.2 *Sheet and Strip* — These forms shall be supplied in one of the tempers given in Table 4 or in deep drawing temper as specified in the purchase order.

7. Grain Size — Strip and sheet for deep drawing shall have an average grain size of 0.065 mm or 16 grains in a square area of 25 mm × 25 mm of image of a magnification of 100.

8. Thermal Expansion — The average linear co-efficient of thermal expansion for iron-nickel-cobalt alloy shall be as indicated in Table 3 when tested with a precision dilatometer in accordance with IS : 3410-1965 'Method of test for determining co-efficient of linear expansion of metals at different temperature ranges'.

9. Transformation — The temperature of the gamme-to-alpha transformation shall be −78.5°C when tested as in Appendix A. However, for material whose smallest dimension is 20 mm, some localized transformation acceptable to the purchaser may be tolerated.

10. Hardness — Sheets and strips for deep drawing applications shall have hardness not exceeding 82 HRB (HV 149) for material 2.5 mm or less in thickness and 85 HRB (HV 170) for material over 2.5 mm in thickness when determined in accordance with IS : 1586-1968 'Methods for Rockwell hardness test (B and C scales) for steel (*first revision*)'. For rolled and annealed condition, tensile strength requirements indicated in Table 4 shall be checked for conformity.

11. Tensile Strength — Tensile strength for wires, rods, sheets and strips shall be as in Table 4 when determined in accordance with IS : 1608-1972 'Method for tensile testing of steel products (*first revision*)'.

TABLE 3 THERMAL EXPANSION CHARACTERISTICS

(*Clause* 8)

Temperature Range °C	**Average Linear Coefficient of Thermal Expansion,** μ**m/m °C**
	Typical Values
30 to 200	5.5
30 to 300	5.1
30 to 400	4.9
30 to 450	5.3
30 to 500	6.2
30 to 600	7.9
30 to 700	9.3
30 to 800	10.4
30 to 900	11.5
	Guaranteed Values
30 to 400	4.60 to 5.20
30 to 450	5.10 to 5.50

TABLE 4 TENSILE PROPERTIES

(*Clauses* 10 and 11)

Designation	**Condition**	**Requirements**, MPa	
		Sheets/Strips	Wires/Rods
0	Annealed	570, *Max*	585, *Max*
1/4H	Quarter-Hard	520 to 630	585 to 725
1/2H	Half-Hard	590 to 700	655 to 795
3/4H	3/4 Hard	660 to 770	725 to 860
H	Hard	700, *Min*	860, *Min*

12. Dimensions and Tolerances

12.1 *Wires and Rounds* — The permissible variation in diameters of wires and rounds shall be in accordance with Table 5.

TABLE 5 PERMISSIBLE VARIATION IN DIAMETERS

Diameter mm		**Tolerance** ± mm
	Cold Drawn Wires in Coils	
0.05 to 0.40		0.008
0.41 to 1.00		0.02
1.01 to 4.00		0.03
	Cold Drawn Centreless Ground Rounds	
4.00 to 12.00		0.050
	Hot Rolled Rounds	
12.01 to 25.00		0.18
25.01 to 50.00		0.25
	Forged Rounds	
Above 50.00		5.00

12.2 The permissible variation in thickness, width and length of strips and sheets shall be in accordance with Table 6 and 7.

TABLE 6 PERMISSIBLE VARIATION IN THICKNESS OF COLD ROLLED STRIP

Thickness mm	Tolerance on Thickness for Width under 225 mm ± mm
Under 0.15	0.02
0.15 to 0.40	0.03
0.41 to 0.60	0.04
0.61 to 0.80	0.05
0.81 to 1.00	0.06
1.01 to 1.25	0.07
1.26 to 1.50	0.08
1.51 to 2.00	0.09
2.01 to 2.50	0.10
2.51 to 3.00	0.12
3.01 to 4.00	0.15

TABLE 7 PERMISSIBLE VARIATION IN WIDTH OF COLD ROLLED STRIPS AND SHEETS

Thickness	Tolerance for a Given Width of		
	4.5 to 12 ±mm	12 to 150 ±mm	151 to 225 ±mm
Under 1.70	0.13	0.13	0.13
1.71 to 2.50	0.20	0.20	0.25
2.51 to 4.00	0.25	0.25	0.41

13. Physical and Mechanical Properties — The physical and mechanical properties are given in Appendix B for information only.

14. Packing and Marking

14.1 Wires and strips supplied in coils shall be wrapped all around with a polyethylene lined hessian cloth. The coils shall be packed in wooden cases to avoid damage during transit.

14.2 Wires of smaller diameter supplied in spools shall be packed in polyethylene bags containing the required quantity of desiccant for absorption of moisture.

14.3 Rods and sheets supplied in cut lengths shall be covered with hessian and secured with hoop iron before packing in wooden cases.

14.4 The wooden cases shall be indelibly marked with the manufacturer's name, mass, dimensions, batch number, description and purchase order reference.

14.5 *Standard Marking* — Details available with the Bureau of Indian Standards.

15. Basis of Order — Purchase orders for materials under this specification shall include the following information;

a) Description and dimensions,

b) Conditions

c) Surface finish,

d) Packing and marking, and

e) IS number.

APPENDIX A

(*Clause* 9)

METHOD OF TEST FOR TRANSFORMATION

A-1. Cut the specimen from any part of the material but preferably including the entire cross-section, degrease it and heat-treat the specimen as follows:

A-1.1 Heat the specimen in hydrogen atmosphere for 1 hour at 900°C followed by 15 minutes at 1100°C. Between 900 and 1100°C of the heat treatment periods, the specimen may be cooled to room temperature, if desired. Cool the specimen from 1100 to 200°C in hydrogen atmosphere at a rate not exceeding 5°C per minute.

A-1.2 After cooling, polish the cross-section of the specimen and etch using a solution of three parts by volume of concentrated nitric acid saturated with cupric chloride. This etchant is more effective when allowed to stand for 20 minutes after mixing.

After several hours, it loses its strength and should be discarded at the end of the day. Etching is best accomplished by swabbing the specimen with cotton soaked with the etchant. Etching is complete when the surface of the metal appears to have turned dull.

A-1.3 Subject the specimen to the temperature produced by an excess of dry ice in acetone (−78.5°C) for at least 4 hours. After the low temperature treatment, examine the specimen at a magnification of 150X for the presence of acicular crystal characteristic of the alpha-phase. Because these crystals may occur only in small localized areas, examine the entire polished cross-section.

A-1.4 Specimens that show no transformation and that show partial transformation are illustrated in Fig. 1 and 2, respectively.

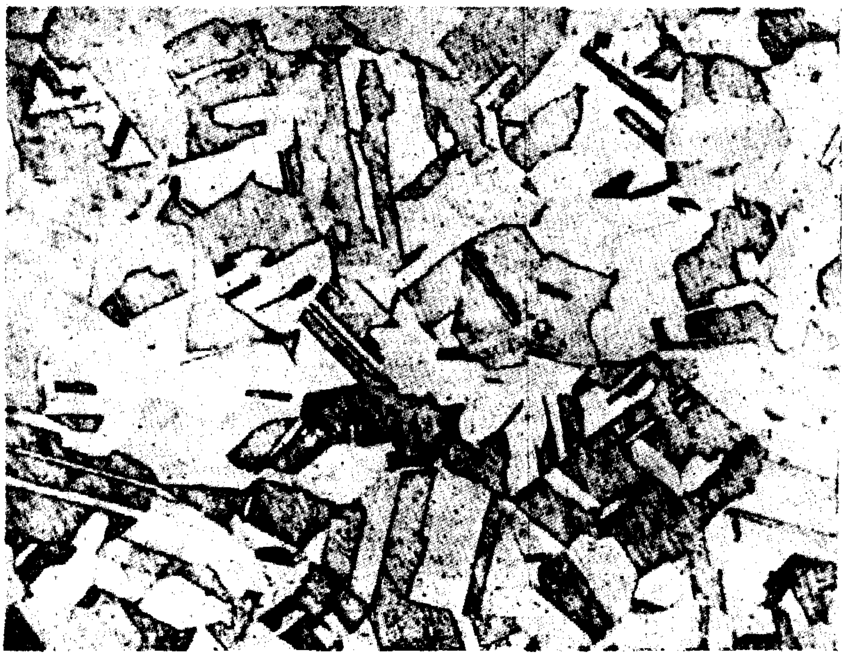

FIG. 1 NORMAL ANNEALED SPECIMEN SHOWING NO TRANSFORMATION, 150 X

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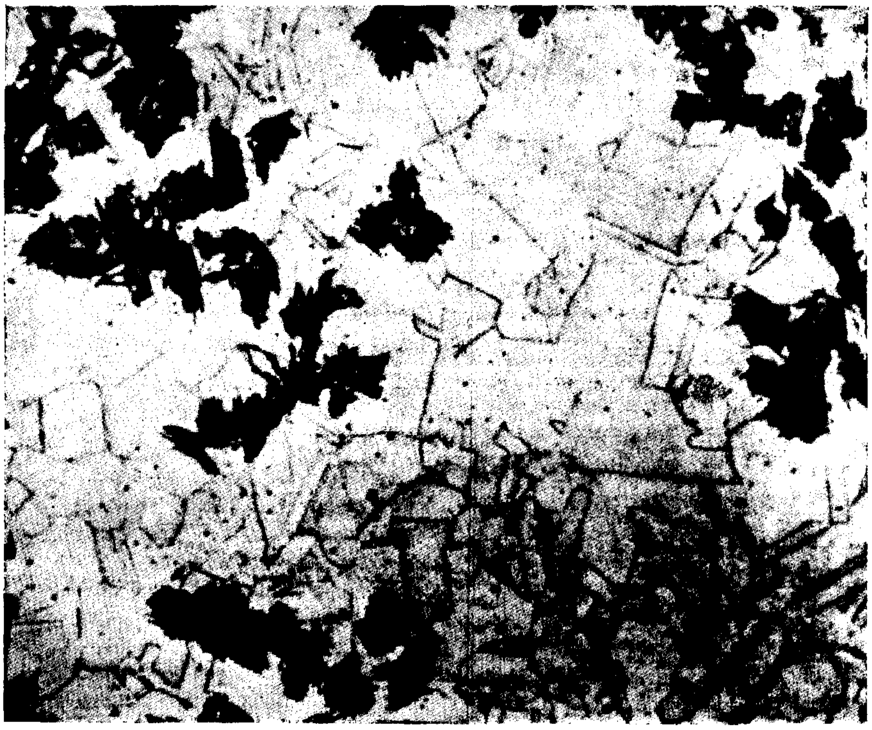

FIG. 2 PARTIALLY TRANSFORMED SPECIMEN, 150 X.

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APPENDIX B

(*Clause* 13)

PHYSICAL AND MECHANICAL PROPERTIES OF IRON-NICKEL-COBALT ALLOY

(For Information Only)

Sl No.	Property	Unit	Value
1.	Density	g/cm^3	8.15
2.	Specific heat	kcal/kg°C	0.12
3.	Thermal conductivity	kcal/mh°C	14.4
4.	Electrical resistivity	Microhm-m	0.45
5.	Curie point	°C	430
6.	Melting point	°C	1 450
7.	*0.2 percent proof stress	MPa	400
8.	*Elongation on 50 mm gauge length	percent	27
9.	*Hardness	HV	163

*Properties in annealed condition.

B-1. Weldability — This alloy can be welded by MIG, TIG, plasma, electronic bombardment and resistance welding. The filler rod should preferably be of the same composition for obtaining optimum joint characteristics. The weld width should be kept minimum. It is recommended to stress-relieve the welded parts by annealing them at 350°C for 2 hours.

EXPLANATORY NOTE

Iron-nickel-cobalt alloy is a controlled expansion super alloy characterized by high strength in long term exposure to working temperatures of 500 to 1 100°C. The important properties of this alloy are uniform thermal expansion and physical properties, close analysis tolerances and low contents of non-metallic inclusions.

This alloy is intended for obtaining stress-free glass-to-metal seals capable of maintaining their integrity in wide range of environment. The alloy finds application in the manufacture of components used in electron tubes requiring glass-to-metal seals, headers and leads in transistors and diodes lead frames in flat pack and dual-in-line packages of semiconductor devices.

This standard has been prepared as a guide to the manufacturers and users of iron-nickel-cobalt alloy which is famillarly known as 'KOVAR' or 'FERNICO'. In the preparation of this standard, necessary assistance has been obtained from the following overseas standards:

ASTM F 15-1978	Iron-nickel-cobalt sealing alloys, American Society for Testing and Materials.
TGL 24 329-1984	Controlled expansion alloys semiconductors. West German Standards Body.

Physical and mechanical properties in addition to those included under test requirements have also been furnished in Appendix B for information only.

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